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Systematic Review

Indication and timing of soft tissue augmentation at maxillary and mandibular incisors in orthodontic patients. A systematic review

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SUMMARY
OBJECTIVE: To assess the indication and timing of soft tissue augmentation for prevention or treatment of gingival recession when a change in the inclination of the incisors is planned during orthodontic treatment.
MATERIALS AND METHODS: Electronic database searches of literature were performed. The following electronic databases with no restrictions were searched: MEDLINE, EMBASE, Cochrane, and CENTRAL. Two authors performed data extraction independently using data collection forms.
RESULTS: No randomized controlled trial was identified. Two studies of low-to-moderate level of evidence were included: one of prospective and retrospective data collection and one retrospective study. Both implemented a periodontal intervention before orthodontics. Thus, best timing of soft tissue augmentation could not be assessed. The limited available data from these studies appear to suggest that soft tissue augmentation of bucco-lingual gingival dimensions before orthodontics may yield satisfactory results with respect to the development or progression of gingival recessions. However, the strength of the available evidence is not adequate in order to change or suggest a possible treatment approach in the daily practice based on solid scientific evidence.
CONCLUSIONS: Despite the clinical experience that soft tissue augmentation of bucco-lingual gingival dimensions before orthodontic treatment may be a clinically viable treatment option in patients considered at risk, this treatment approach is not based on solid scientific evidence. Moreover, the present data do not allow to draw conclusions on the best timing of soft tissue augmentation when a change in the inclination of the incisors is planned during orthodontic treatment and thus, there is a stringent need for randomized controlled trials to clarify these open issues.

Introduction

Gingival recession refers to the apical displacement of the gingival margin from the cemento-enamel junction (Kassab and Cohen, 2003). Recessions can be localized or may involve more teeth or tooth surfaces. The resulting root surface exposure often causes aesthetic concerns (Smith, 1997), dentin hypersensitivity (Lawrence *et al.*, 1995), and increased susceptibility to root caries (Al-Wahadni and Linden, 2002). Gingival recessions have been found to be more frequent in mandibular than maxillary teeth, and on facial than lingual surfaces, especially with increasing age (Khocht *et al.*, 1993).

As early as 1976, a justification regarding the pathogenesis of gingival recession was brought forward (Baker and Seymour, 1976). Localized inflammation in a 'thin type' gingiva might involve the entire volume of gingival tissue and the consequent remodelling could lead to recession of gingival margin. On the other hand, in a 'thick type' gingiva, this inflammatory lesion could be confined to only a part of the sulcus leaving the 'outer gingival tissue' unaffected. This could probably predispose to pocket formation rather than recession. Although the proposal of this mechanism was based on a rat model, it may be considered as the primary concept, which recognized that the thin gingival biotype can be a risk factor for recession. Additionally, many other factors may as well play a role in the development of gingival recession, not necessarily simultaneously or equally. Periodontal diseases and mechanical trauma are the two primary etiologic factors in the pathogenesis of gingival recessions (Löe *et al.*, 1992; Smith, 1997; Kassab and Cohen, 2003; Litonjua *et al.*, 2003; Rawal *et al.*, 2004; Levin *et al.*, 2005). Traumatic tooth brushing appears to be one of the important factors associated with gingival recessions (Khocht *et al.*, 1993). Other,

secondary etiologic factors might include existing bone dehiscences, smoking, and intraoral and perioral piercings (Albandar *et al.*, 2000; Susin *et al.*, 2004; Levin *et al.*, 2005).

A possible etiological factor for gingival recession is the orthodontic movement of teeth, especially the movement of teeth to positions outside the labial or lingual alveolar plate, which could lead to development of dehiscence (Wennström *et al.*, 1987). A systematic review indicated that proclination and movement of the mandibular incisors out of the osseous envelope of the alveolar process may be associated with a higher tendency for developing gingival recessions. On the other hand, the amount of recession found in the included studies, which showed statistically significant differences between proclined and not proclined incisors, was small and the clinical consequence regarded as questionable (Joss-Vassalli *et al.*, 2010). The precise mechanism by which orthodontic treatment influences the occurrence of recessions remains unclear. It has been assumed that the presence of bony dehiscence before the beginning of orthodontic therapy is a prerequisite for the development of gingival recession (Wennström, 1996). Because a bony dehiscence does not always lead to recession (Thilander *et al.*, 1983), other factors, as the ones described above, must be present.

Among the numerous orthodontic treatment procedures and modalities, the issue of incisor proclination outside their dentoalveolar envelope as a source of gingival recession has been considered for years. Although it is broadly believed that mandibular incisor proclination leads to gingival recession, there are very few clinical studies that have actually investigated this. Some of them have shown gingival recession to be associated with proclination of the mandibular incisors (Årtun and Krogstad, 1987; Yared *et al.*, 2006), whereas others have found no such correlation (Ruf *et al.*, 1998; Djeu *et al.*, 2002; Allais and Melsen, 2003). A series of recent retrospective studies has shown that although the change of inclination of lower incisors during orthodontic treatment may not affect the development of labial recessions (Renkema *et al.*, 2012), nevertheless, these teeth are the most vulnerable to development of recessions (Renkema *et al.*, 2013a), with their prevalence being age dependent and increasing steadily in the period between before and 5 years after therapy (Renkema *et al.*, 2013b).

Periodontal prevention of gingival recessions in orthodontic patients remains, likewise, contradictory. Historically, periodontists have indicated gingival augmentation to recreate the zone of attached gingiva. The early concept for this approach was that attached gingiva is important to dissipate the force of muscle pull and unattached mucosa. Many still believe that attached gingiva is more suitable to withstand the trauma of mastication and tooth brushing (Corn, 1962; Carranza and Carraro, 1970; Lang and Löe, 1972).

Such periodontal augmentation procedures include free gingival grafts, coronally positioned flap, subepithelial connective grafts, acellular dermal grafts, and enamel matrix proteins. Among them, subepithelial connective tissue grafts are generally considered as a 'gold standard' in gingival augmentation (Roccuzzo *et al.*, 2002; Chambrone *et al.*, 2008). Opposite to this preventive concept, however, some clinicians consider this approach as overtreatment and prefer to wait until the potential gingival recession becomes a pathological and clinical entity. Subsequently, the developed recession may be treated during or after orthodontic therapy.

Although some guidelines exist about how much is adequate when it comes to the thickness of the attached gingival (Lang and Löe, 1972), the decision about its adequacy to withstand the stress and adverse effects related to mandibular incisor increase in inclination as well as the timing of the proposed periodontal intervention remains a highly subjective issue. Despite of the presence of some scarce evidence in the literature on this subject, a synthesis of their results has not been published yet.

The aim of this systematic review was, therefore, to search and assess the available literature in order to appraise if, first of all, soft tissue augmentation is indicated for prevention or treatment of gingival recession, and at which point of time related to orthodontic treatment, when a change in the inclination of the incisors is anticipated.

Materials and methods

Selection criteria applied for the review

- Study design: prospective and retrospective studies were considered in this review, including randomized clinical trials, controlled clinical trials, and other observational studies in the absence of the first. Animal studies were not considered eligible for inclusion in this review. Case reports were also excluded.
- Types of participants: patients referred for orthodontic treatment. Any age of patients was accepted.
- Types of intervention: periodontal treatment for the prevention or treatment of gingival recessions including gingival or epithelial grafting for soft tissue augmentation. Fixed orthodontic appliances that were designed to alter the inclination of the mandibular and/or maxillary incisors.
- Outcome: success of periodontal therapy of gingival recessions adjunct to alteration of incisors' inclination. Timing of periodontal treatment was associated with the main outcome.
- Timing of periodontal treatment: no restriction was applied regarding the points of time that periodontal therapy may have taken place (before/during/after orthodontic treatment).
- Exclusion criteria: orthodontic translative (bodily) tooth movement through grafts, orthodontic tooth movement other than inclination, teeth other than mandibular/maxillary incisors.

Search strategy for identification of studies

For the identification of studies included or considered for this review, detailed search strategies were developed for each database searched. They were based on the search strategy

developed for MEDLINE but revised appropriately for each database to take account of differences in controlled vocabulary and syntax rules. The following electronic databases were searched: MEDLINE (via Ovid and PubMed, Appendix 1; 1946 to April week 4, 2013), EMBASE (via Ovid), the Cochrane Oral Health Group's Trials Register, and CENTRAL.

Unpublished literature was searched on ClinicalTrials.gov (date last accessed, September 26, 2013), the National Research Register, and Pro-Quest Dissertation Abstracts and Thesis database.

The search attempted to identify all relevant studies irrespective of language. There were no restrictions on date of publication. The reference lists of all eligible studies were handsearched for additional studies.

Selection of studies

Assessment of research for including studies in the review and extraction of data were performed independently and in duplicate by the first two authors who were not blinded to identity of the authors, their institution, or the results of the research. The full report of publications considered by either author to meet the inclusion criteria was obtained and assessed independently. Disagreements were resolved by discussion and consultation with the third author. A record of all decisions on study identification was kept.

Data extraction and management

The first two authors performed data extraction independently and in duplicate. Disagreements were resolved by discussion or the involvement of a collaborator (third author). Data collection forms were used to record the desired information. The following data were collected on a customized data collection form.

- Author/title of study
- Design of the study
- Human race of study participants
- Number/age/gender of patients recruited
- Type of orthodontic therapy and identification of the teeth that were moved
- Force applied to the teeth under treatment
- Orthodontic treatment duration
- Timing of periodontal intervention
- Periodontal procedure and type of grafting material
- Time points of outcome assessment and method of measuring the outcome
- Attainment of desirable tooth movement
- Increase or decrease of gingival recession and possible factors related

Measures of treatment effect

For continuous outcomes, mean differences and standard deviation were used to summarize the data for each study.

Unit of analysis issues

In all cases, the unit of analysis was primarily the patient. In addition, a unit of analysis issue arose due to the different periodontal approaches. To resolve this, a separate analysis for each periodontal technique was planned to be used, where applicable.

Data synthesis

A meta-analysis was planned to be conducted only if there were studies of similar comparisons, reporting the same outcome measures at the same time points.

Quality assessment

The quality of methodology, performance, and statistics of each study were assessed, and the studies were graded with a score of A, B, or C (grade A: high value of evidence, grade C: low value of evidence) according to predetermined criteria using the system of Bondemark *et al.* (2007). This, validated also in other studies, system describes the criteria for grading the studies as follows:

- Grade A: high value of evidence (all criteria should be met):
  - Randomized clinical study or a prospective study with a well-defined control group.
  - Defined diagnosis and end points.
  - Diagnostic reliability tests and reproducibility tests described.
  - Blinded outcome assessment.
- Grade B: moderate value of evidence (all criteria should be met):
  - Cohort study or retrospective case series with defined control or reference group.
  - Defined diagnosis and end points.
  - Diagnostic reliability tests and reproducibility tests described.
- Grade C: low value of evidence (one or more of the following conditions):
  - Large attrition.
  - Unclear diagnosis and end points.
  - Poorly defined patient material.

Results

Description of studies

Studies that were initially deemed potentially relevant for the review were retrieved and inclusion criteria were applied. Tracking the eligible for inclusion studies appeared to be a difficult task. Many case reports, several studies examining orthodontic tooth movement through grafts, or studies

examining other than inclination types of movement exist in the field, which were not relevant for this review. After removal of the duplicates, abstract and full text reading stage, two studies were finally regarded as eligible for inclusion (Figure 1). Both studies were included in the qualitative analysis but a quantitative synthesis was not appropriate. No randomized controlled trial was identified. One study had both prospective and retrospective data collection (Maynard and Ochsenbein, 1975), and the other had a retrospective design (Ngan *et al.*, 1991; Tables 1 and 2). Both implemented a periodontal intervention before orthodontic treatment.

Quality assessment

One study was graded as moderate (grade B) value of evidence and this was the retrospective one (Ngan *et al.*, 1991). The second was graded as low value of evidence (grade C). The reason was the poorly defined patient material (Maynard and Ochsenbein, 1975).

Qualitative synthesis of the included studies

Study settings. An overview of the experimental setup of the included studies is given in Table 1. In the first study (Maynard and Ochsenbein, 1975), autogenous free gingival graft was implemented as a preventive measure, before orthodontics, in some young patients (exact number not given). These consisted a part of a sample of 100 children. Mandibular central incisors were evaluated. In the second study (Ngan *et al.*, 1991), the authors divided their 20 patients with more than 1 mm labial recession on one or more mandibular central incisors before treatment in two groups: one group received autogenous free gingival graft in the area of recession prior orthodontics and the second group (control group) had no graft before orthodontics. In both groups, the incisors were retroclined during treatment.

Clinical findings. Table 2 gives an overview of the results of the included studies regarding clinical parameters. Both studies have used periodontal surgery (e.g. soft tissue grafting) before orthodontic treatment. Consequently, the issue on the best timing (before, during, or after orthodontic treatment) could not be assessed.

Maynard and Ochsenbein (1975) stated that autogenous free gingival graft can be recommended as an acceptable procedure prior to tooth movement, where orthodontic therapy is anticipated and insufficient keratinized tissue exists. According to the authors, grafts can be recommended in patients with 1 mm or less of keratinized tissue.

Ngan *et al.* (1991) found out that teeth presenting true gingival recession had statistically less gingival recession after being retroclined, with no difference detected between grafted and ungrafted recessions. It was, however, a study, during which teeth were retroclined and not proclined.

Quantitative synthesis of the included studies

The lack of standardized protocols precluded a valid interpretation of the actual results of the studies. Methodological heterogeneity refers to important differences in the interventions, participants, and outcomes of the included studies and similarly for studies other than randomized clinical trials. Although both studies implemented surgical periodontal therapy before orthodontic treatment, the analysis of the indication and methodology revealed substantial differences with respect to the sample size, the type of periodontal procedure or regenerative material, and the time points of outcome assessment. Therefore, a meta-analysis was not possible.

Discussion

The inclination and the projected (empirically or through Visual Treatment Objective) post-treatment position of the mandibular or maxillary incisors play an important role in the diagnostic process and orthodontic treatment planning. It is frequently necessary to first establish proclination tolerance limits before treatment, especially in patients with severe skeletal discrepancies, with arches that can accommodate only a limited number of teeth, or in patients with inadequate attached gingiva. These limits to estimated proclination refer to biological factors, such as the characteristics and quality of the periodontal tissues in the area and thus, patients who already have thin soft tissue margins before treatment should be treated with caution.

Recession is not probably a direct consequence of incisor proclination. A relevant systematic review found no association between appliance-induced labial movement of mandibular incisors and gingival recession (Aziz and Flores-Mir, 2011). The authors recommended to also focus on other predisposing conditions of the mandibular anatomy before orthodontic planning, as far as it concerns recessions. On the other hand, some studies have shown that excessive final inclination of incisors, in addition to individual characteristics of thin gingival margin and other local or even systemic factors, can render it susceptible to the development of recession defects (Årtun and Krogstad, 1987; Yared *et al.*, 2006). It can be anticipated that if the gingival margin maintains an appropriate thickness after orthodontic treatment, the tissue would be more resistant and less affected by tension from excessive proclination. Consequently, the risk for developing gingival recession could be significantly reduced.

The issue of preventive periodontal intervention before orthodontic treatment, and especially before inclination of the incisors, has been long discussed in the scientific community (Maynard and Ochsenbein, 1975; Mehta and Lim, 2010). The objective of this systematic review was to include the results of as many studies as possible to obtain

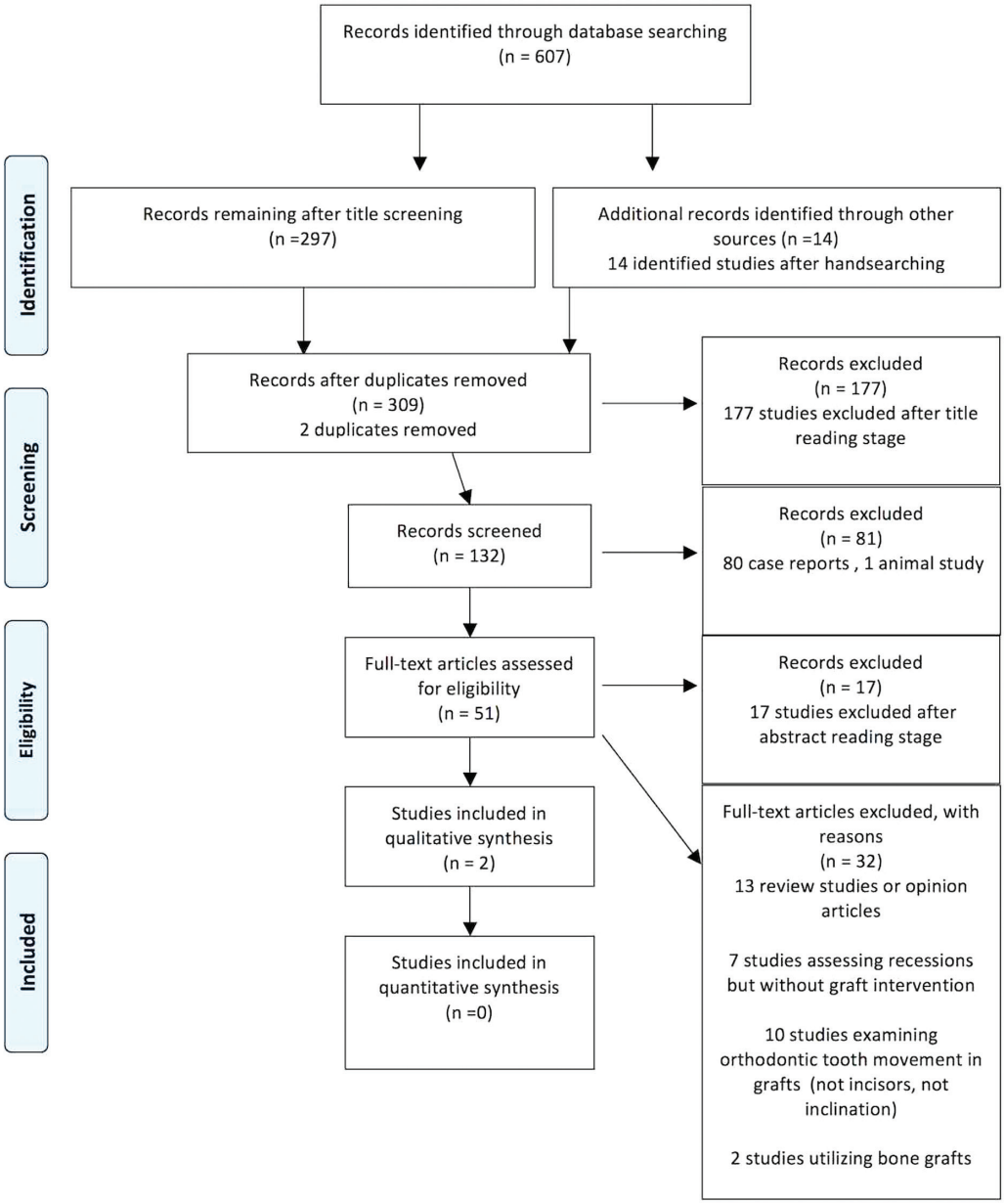

Figure 1 Study Flow Diagram. From Moher D, Liberati A, Tetzlaff J, Altman D G, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6: e1000097. doi:10.1371/journal.pmed1000097. For more information, visit www.prisma-statement.org (date last accessed, September 26, 2013).

information on the development or prevention of gingival recessions after combined periodontal–orthodontic treatment.

The low-to-moderate level of evidence of the included studies and the application of different periodontal procedures, analysed at different time intervals, made the analysis of the results impossible. Treatment duration, control groups, force applied, and grafting materials varied substantially, making the calculation of pooled estimates unfeasible.

Despite the lack of consistency in methodological approaches, and taking into account that the available evidence derived from studies, which command a low to moderate level of evidence, the qualitative analysis of the included studies revealed that:

- Periodontal soft tissue augmentation of bucco-lingual gingival dimensions before orthodontic treatment may yield satisfactory results, as far as it concerns the development or progress of gingival recessions. The lack of high level of evidence, though, cannot render these results generalizable.
- The evaluation of the attached gingiva as adequate or inadequate, and in turn, the need of periodontal intervention before incisor inclination, still remains highly subjective.

Table 1 Design (materials and methods) of included studies.

Author	Study title Study design	Race of humans/ species of animals	Number/ gender/ age of patients	Type of orthodontic therapy/teeth moved	Force applied	Orthodontic treatment duration	Perio prior or after ortho/ procedure and type of grafting material	Time points of outcome assessment/how outcome was assessed
Maynard and Ochsenbein (1975)	Mucogingival problems, prevalence and therapy in children *Retrospective and prospective*	Humans Race not reported	100 children	Fixed appliances Mandibular central incisors were evaluated	Not reported	Not reported	Perio as preventive intervention prior to ortho. (after subjective evaluation of the clinician) Autogenous gingival graft in some patients (how many not reported)	Before and after ortho. Width of keratinized gingiva and depth of the gingival crevice were measured with a probe
Ngan *et al.* (1991)	Grafted and ungrafted labial gingival recession in paediatric orthodontic patients: effects of retraction and inflammation *Retrospective*	Humans Race not reported	20 children 12 females 8 males 11–16 years of age All patients presenting labial recessions	Fixed appliances Mandibular central incisors were evaluated (retroclination)	Not reported	18–30 months (mean 24 months)	Perio prior to ortho. 10 patients received autogenous gingival grafts in the area of recession prior to orthodontics, while 10 received no graft	Before and after ortho. Gingival recessions were measured on projected transparent slides after photos taken from patients

Table 2 Results of included studies.

Study	Desirable tooth movement and achieved/not achieved	Gingival recession (increase/decrease)	Gingival recession related/not related to:
Maynard and Ochsenbein (1975)	Not reported	No additional gingival recession was observed over the grafted teeth.	Where orthodontic therapy is anticipated and coincidentally insufficient keratinized tissue exists, a free gingival graft should be performed prior to tooth movement. Grafts would be recommended in children with 1 mm or less of keratinized tissue.
Ngan *et al.* (1991)	Retroclination of mandibular incisors (from a pre-orthodontically prominent arch position)	Comparison of the pre-treatment and post-treatment gingival recessions between the control and grafted groups showed no statistically significant differences.	Pre-orthodontic gingival grafting did not further decrease the post-orthodontic gingival recession. It was postulated that the eruption and maturation of incisors during the treatment contributed more to the decreased gingival recession than the graft did.

- The final analysis in the included studies took place immediately after orthodontic therapy. Long-term results are clearly missing on this topic.
- In patients with a 'thin' type of gingiva, soft tissue grafting might be beneficial before orthodontic tooth movement to prevent the development of a gingival recession. Whether this clinical decision can be considered as over-treatment, still remains an open question and should be evaluated in further studies.

The issue of proclination and its potential effect on the periodontal support of the root of mandibular incisors must be considered within the broader context of current treatment trends and practices (Johal *et al.*, 2013). A number of studies supporting the lack of definitive evidence linking proclination with dehiscence, recession, or other unfavourable effect on the periodontal condition of mandibular incisors have indicated minute differences of proclined relative to non-proclined teeth. However, two central arguments relating to the correlation of clinical examination of recessions with the actual status of periodontium and the implication of long-term recession are worth mentioning on this aspect.

First, the examination of the periodontal condition of the affected teeth was performed essentially only clinically without standardized radiographic evidence, thus limiting the identification of the unfavourable sequelae to the clinically detectable signs of gingival recession, with almost no information about the accompanying bone levels. Evidence from autopsy material of an individual who underwent orthodontic treatment and presented no signs of recession clinically, while she showed severe frontal periodontal destruction as evaluated histologically, suggests that this examination (and conventional radiographic antero-posterior assessment of bone levels) might underestimate the impact of orthodontic proclination on tissue damage (Wehrbein *et al.*, 1996). The introduction of cone beam computed tomography could provide clinically relevant information on this issue (Enhos *et al.*, 2012), despite its limitations regarding overestimation of bone fenestrations and dehiscences (Leung *et al.*, 2010; Patcas *et al.*, 2012).

Secondly, with recent suggestions on long-term fixed retention of mandibular teeth (Littlewood *et al.*, 2006), the issue of proclination must be viewed under the perspective of potential induction of effects on the periodontal condition of mandibular teeth after the termination of active treatment. This factor has not been assessed in studies examining the effect of proclination after orthodontic tooth movement. Nevertheless, orthodontic treatment in general, and the following retention phase, may be considered as a risk factor for the development of labial gingival recessions (Renkema *et al.*, 2013a). Furthermore, related evidence on this issue suggests that the clinical condition of periodontium of patients who had received orthodontic treatment with at least 2 mm advancement of their incisal edge, 7.8–9.4 years after treatment, was comparable to patients without such an advancement (Årtun and Grobéty, 2001). However, no information is available on the retention practices in this sample.

Conclusion

Despite the clinical experience that soft tissue augmentation of bucco-lingual gingival dimensions before orthodontic treatment may be a clinically viable treatment option in patients considered at risk, this treatment approach is not based on solid scientific evidence. Moreover, the present data do not allow to draw any conclusion on the best timing of soft tissue augmentation when a change in the inclination of the incisors is planned during orthodontic treatment and thus, there is a stringent need for randomized controlled trials to clarify these open issues.

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Appendix 1: Search strategy PubMed, 29 April 2013

#1	(graft*[Title/Abstract]) AND orthodont*[Title/Abstract]	427
#2	(graft*[Title/Abstract]) AND incisor*[Title/Abstract]	345
#3	(graft*[Title/Abstract]) AND inclin*[Title/Abstract]	166
#4	(#1) NOT cleft*[Title/Abstract]	197
#5	(transplant*[Title/Abstract]) AND orthodont*[Title/Abstract]	180
#6	(#5) OR #4	360
#7	(#6) AND timing[Title/Abstract]	7
#8	(#6) AND time[Title/Abstract]	72
#9	"Tissue Transplantation"[Mesh] AND orthodont*	48
#10	"transplantation" [Subheading] AND orthodont*	430
#11	(periodont*[Title/Abstract]) AND orthodont*[Title/Abstract]	2478
#12	Add Search (#11) AND graft*[Title/Abstract]	83
#13	(#11) AND recession[Title/Abstract]	88
#14	(#13) AND graft*[Title/Abstract]	13
#15	((orthodont*[Title/Abstract]) AND recession*[Title/Abstract]) AND graft*[Title/Abstract]	26